Southwest Regional Partnership on Carbon Sequestration

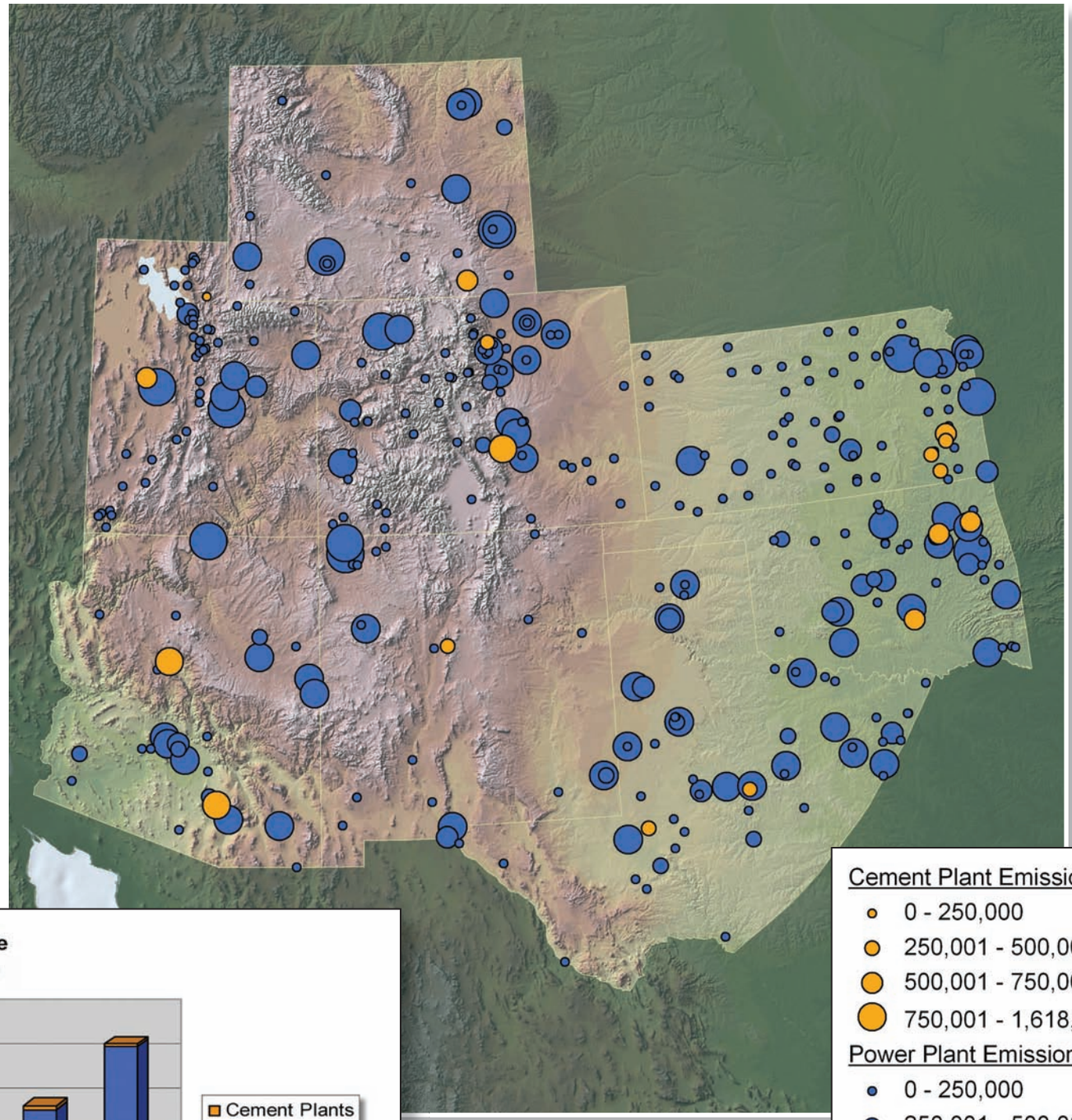
The Southwest Regional Partnership (SWP) on Carbon Sequestration was created to determine the best approaches to advance early commercial opportunities for the use of carbon sequestration—carbon capture and storage (CCS) systems. CCS has the potential to be a cost-effective option to mitigate CO_2 emissions. SWP is comprised of a diverse group of experts in geology, engineering, economics, public policy, and outreach. These groups are utilizing their expertise to assess sequestration technologies to capture carbon emissions, identify and evaluate appropriate storage locations, and engage a variety of stakeholders to increase awareness of carbon sequestration. Stakeholders in this project are made up of private industry, Non-government Organizations (NGOs), the general public, and government entities. A total of 21 organizations are currently represented in the partnership including electric utilities, oil and gas companies, state governments, universities, NGOs, and tribal nations.

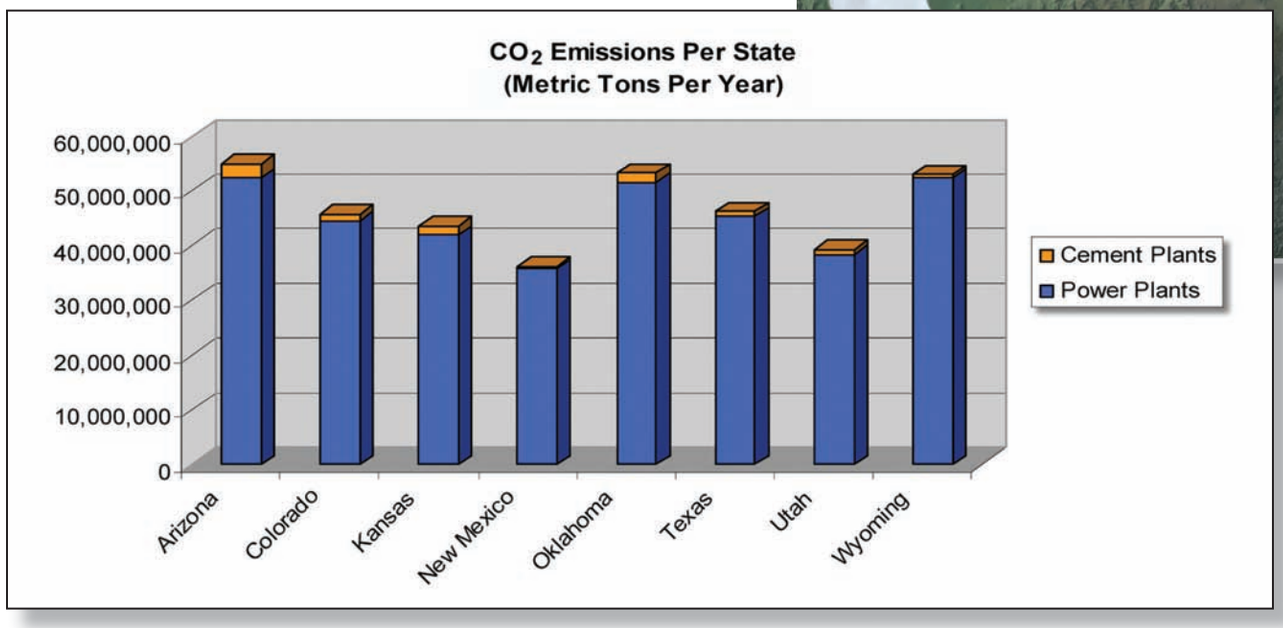
Led by the New Mexico Institute of Mining and Technology, the SWP includes New Mexico, Arizona, Colorado, Oklahoma, Utah, and portions of Kansas, Nevada, Texas, and Wyoming. Field test sites for the Region are located in New Mexico (San Juan Basin), Utah (Paradox Basin), and Texas (Permian Basin).

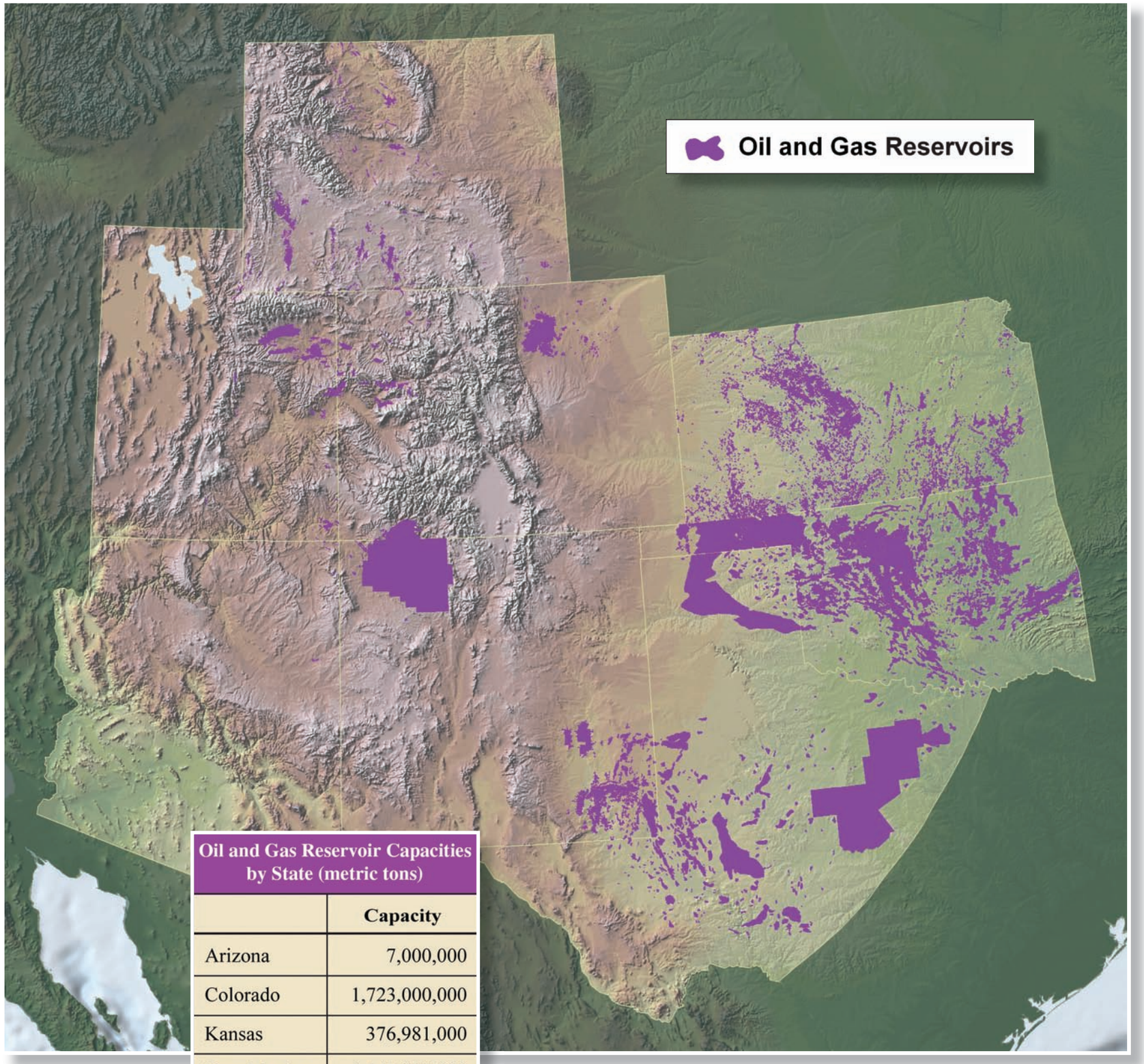
SWP
SOUTHWEST PARTNERSHIP
CO_2 SEQUESTRATION

SWP Region CO_2 Emission Sources

The Southwest Region is energy-rich and possesses one of the largest population and energy-production growth rates in the Nation. Two major CO_2 pipeline networks transport more than 27 million metric tons (30 million tons/yr) of natural, subsurface CO_2 from southern Colorado and northern New Mexico to petroleum fields in the Permian Basin of west Texas and eastern New Mexico, where it is used for EOR. The 10 largest coal-fired power plants in the Region produce about 127 million metric tons (140 million tons of CO_2/yr). Other stationary sources include natural gas processing plants, refineries, ammonia/fertilizer, ethylene and ethanol, and cement plants.







Oil and Gas Reservoir Capacities by State (metric tons)	
	Capacity
Arizona	7,000,000
Colorado	1,723,000,000
Kansas	376,981,000
New Mexico	8,246,000,000
Oklahoma	10,012,000,000
Utah	1,405,000,000

SWP Oil and Gas Reservoirs

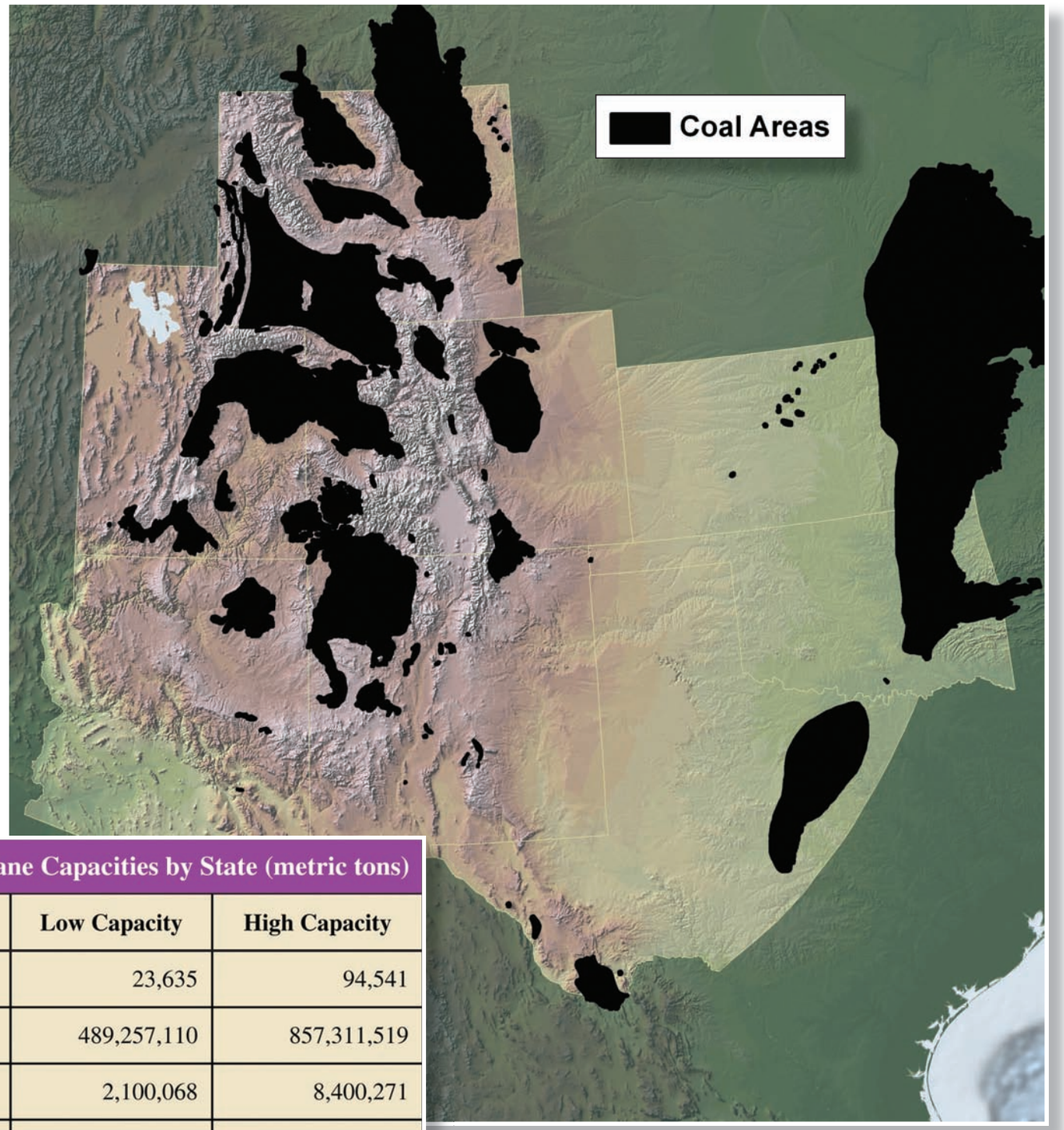
The Aneth oil field, discovered in 1956, is one of the largest in the Nation. The Aneth Unit is part of the Greater Aneth Field and is located in the Paradox Basin of southeastern Utah. The Aneth Unit is a stratigraphic trap with fractures and minor faults that cover about 68 km^2 (26 mi^2) of the northern section of the greater Aneth Field. To date, it is estimated that about 24 million m^3 (149 million barrels) of an estimated 67 million m^3 (421 million barrels) of OOIP have been produced from the Aneth Unit. The pilot test site is located within the Aneth mound complex, which formed on a weak structural nose. The present-day structural relief of about 46 m (150 ft) is largely the result of differential compaction. The primary CO_2 sequestration target is the Pennsylvanian Desert Creek formation and overlying Ismay members of the Paradox formation, the primary producers in the Greater Aneth Field.

In Texas, the SACROC oil field unit and the Claytonville Canyon Lime reservoir produce oil from Pennsylvanian-age strata. The SACROC oil field unit lies along a trend of fields described as the Horseshoe Atoll Play. The Claytonville Canyon Lime reservoir lies east of SACROC in the Pennsylvanian Reef/Bank Play. This play trends north-south along the east edge of the Midland Basin and follows the paleo-Strawn and Canyon shelf edges. Target reservoirs in this unit include the producing Pennsylvanian carbonates in both fields.

SWP Unmineable Coal Seams

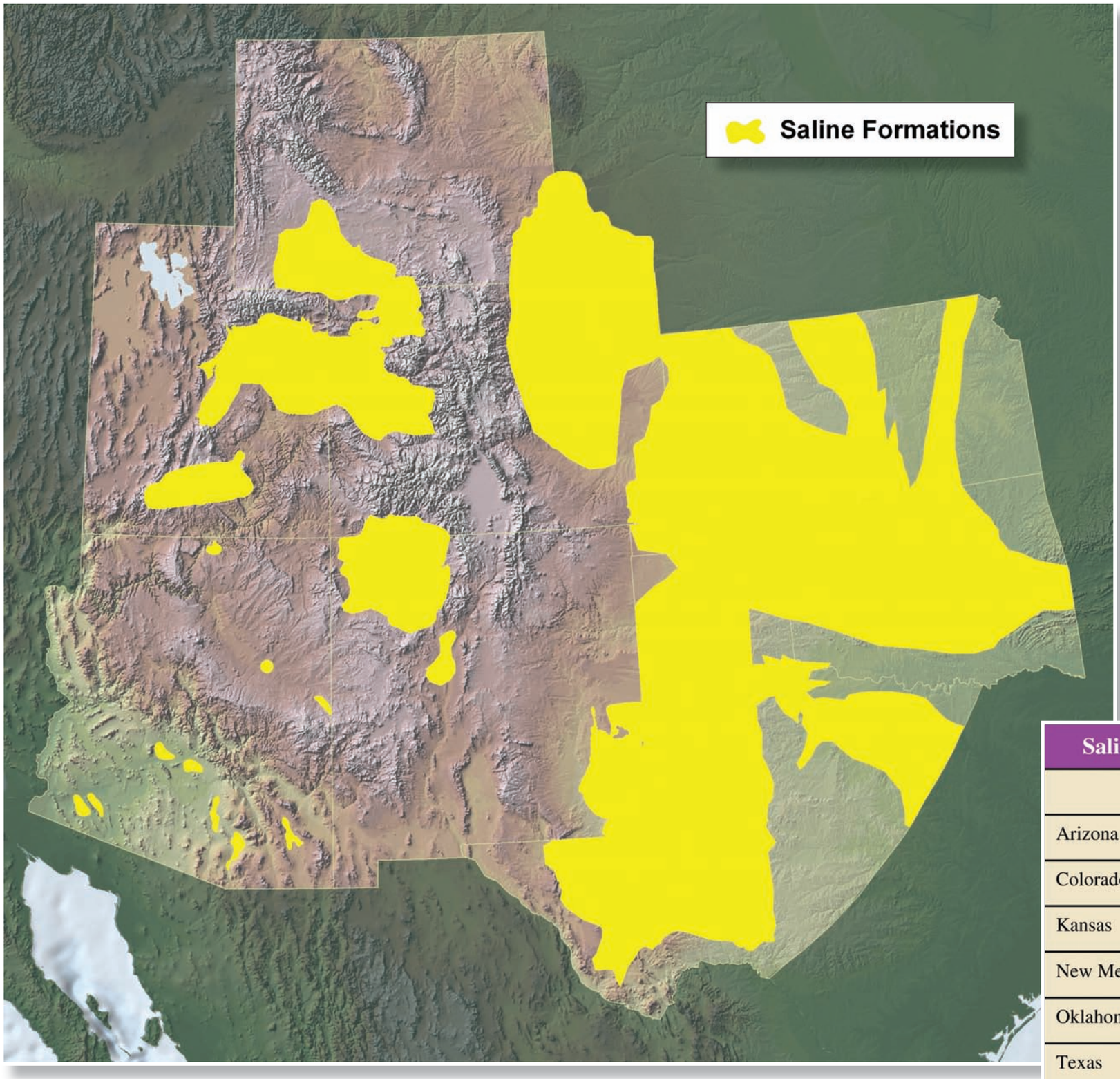
The San Juan Basin (SJB) in New Mexico is one of the top ranked basins in the world for CO_2 coalbed sequestration because it has (1) advantageous geology and high methane content, (2) abundant anthropogenic CO_2 from nearby power plants, (3) low capital and operating costs, (4) well developed natural gas and CO_2 pipeline systems, and (5) local companies with CBM and ECBM expertise. Because of its enormous coal resource, the SJB offers a tremendous sequestration opportunity with value-added natural gas production. An extensive CO_2 infrastructure is already in place, making the area ready for future operations.

The coals in the SJB area are of exceptionally high permeability. Due to the tendency of coal to swell when in contact with CO_2, high initial coal permeability is required to maintain high CO_2 injection rates over time. Maintaining high injectivity is an important requirement for large-scale, low-cost CO_2 sequestration in coal. Coal has a tendency to swell when injected with CO_2. Since maintaining high injectivity is an important requirement, it is important to locate CO_2 sequestration operations in areas where coal permeability is high. The coals in the SJB formation are of exceptionally high permeability and should be well suited to ECBM.



Coalbed Methane Capacities by State (metric tons)

	Low Capacity	High Capacity
Arizona	23,635	94,541
Colorado	489,257,110	857,311,519
Kansas	2,100,068	8,400,271
New Mexico	75,440,909	301,763,636
Oklahoma	1,845,792	7,383,169
Utah	30,514,535	122,058,139
Wyoming	194,299,134	777,196,534



SWP Deep Saline Formations

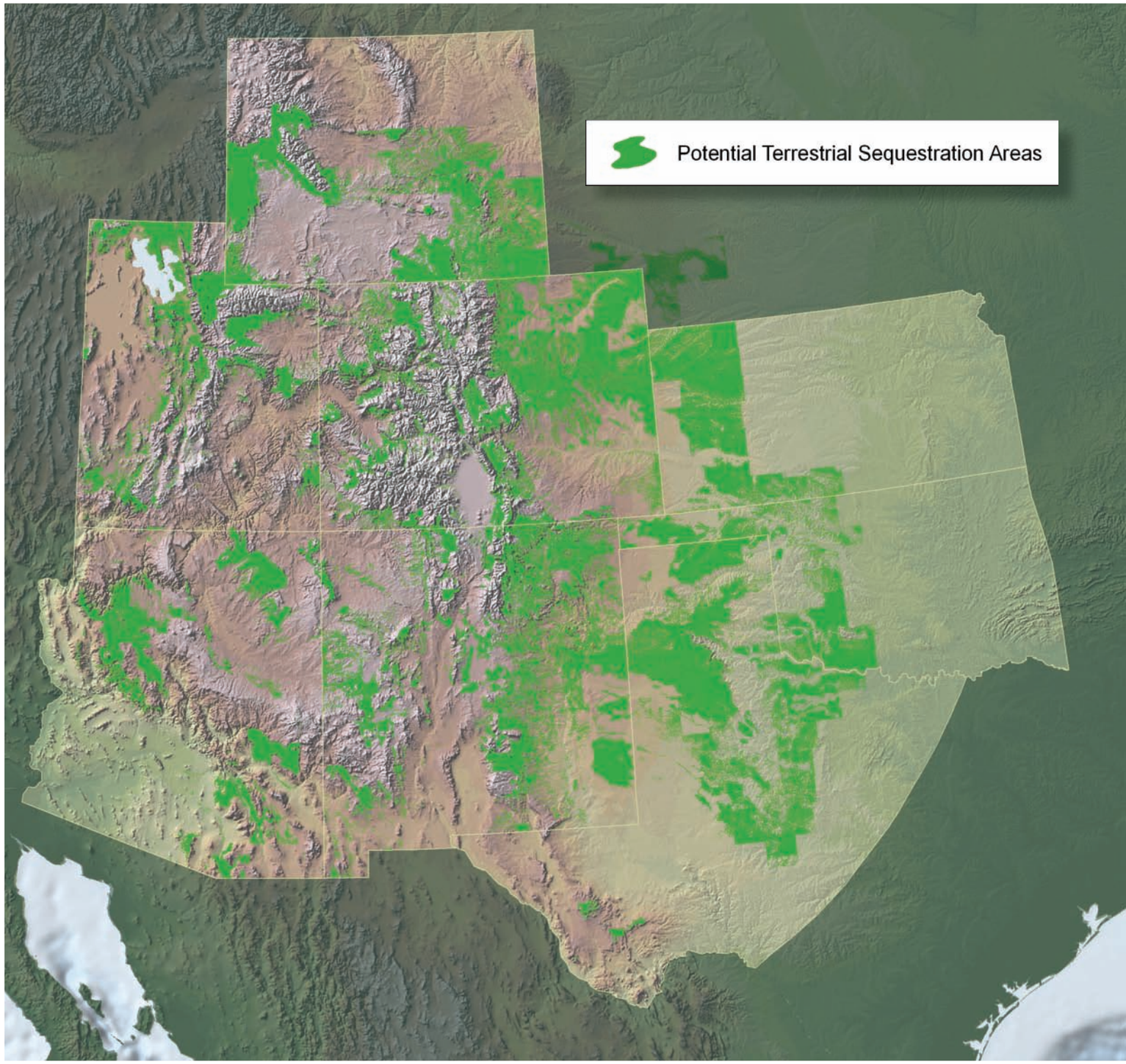
In addition to the EOR work, the Aneth Unit site includes a deep saline formation. The carbonate strata deposited on the southwestern flank of the Paradox evaporite basin are laterally equivalent to the more basinward anhydrites and salts. The Aneth Unit was originally developed with vertical wells drilled on 80-acre spacing. The field was infill drilled in the 1970s to 40 acre spacing. The field has been managed with water injection that began with unitization in the early 1960s. In 1996 Texaco drilled 43 multi-lateral horizontal wells, and in 1998, the injectors in section 14 were converted to a CO_2 Water Alternating Gas project to pilot the possibility of a field wide CO_2 injection program. Thus, monitoring of horizontal CO_2 injection is an added attraction offered by this pilot test site.

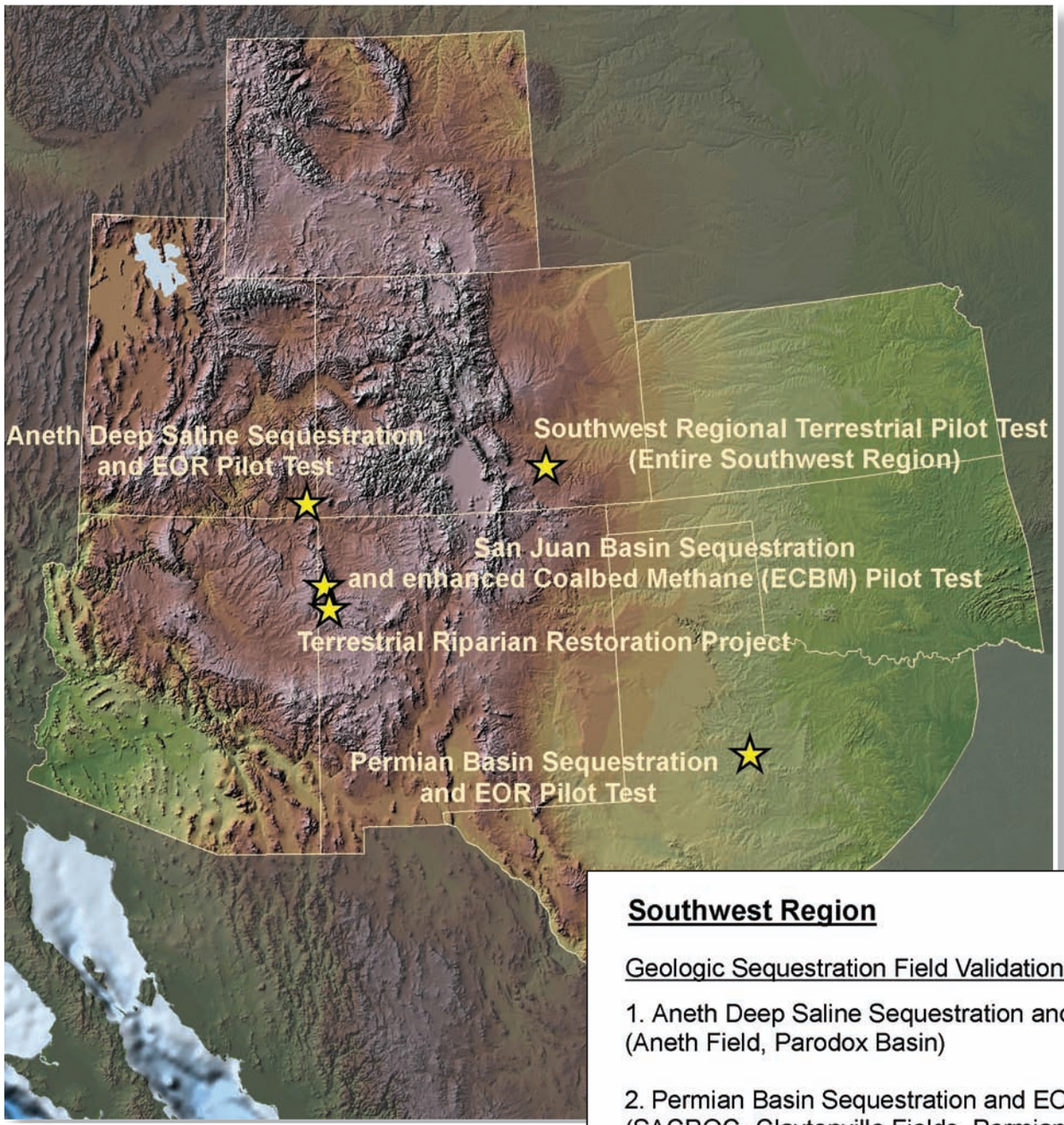
Saline Formation Capacities by State (metric tons)

	Low Capacity	High Capacity
Arizona	23,229,973	92,919,891
Colorado	972,198,156	3,888,792,622
Kansas	2,668,000,000	10,674,000,000
New Mexico	2,475,016,534	9,900,066,137
Oklahoma	2,348,363	9,396,116
Texas	11,931,102,028	47,724,408,110
Utah	127,193,409	508,773,637
Wyoming	126,922,334	507,689,335

SWP Terrestrial Opportunities

In conjunction with the SWP's ECBM test, a terrestrial pilot test is being conducted in the San Juan Basin. ECBM operations are notorious for producing huge volumes of water. This water source could potentially be desalinated and used for irrigating a riparian restoration project, forming a combined ECBM—terrestrial sequestration project. The Bureau of Land Management and Burlington Resources are both interested in making beneficial and environmentally friendly use of the produced water. Rangelands in the San Juan Basin of New Mexico are a plausibly large reservoir for CO_2, in addition to their value as recreational lands. The challenges to achieving their potential lie primarily in the limited growing conditions and reduced capacity for recovery. Optimizing carbon storage in soils and vegetation while increasing the value of other ecosystem services requires a two-pronged strategy: enhancing existing plant growth and reintroducing woody plant species along riparian areas and reestablishing native grasses and shrubs in upland areas. The limiting factor in both cases is water. A reliable source of water for agricultural irrigation, such as the water produced during ECBM production, could provide the necessary base for the reestablishment of native vegetation with a host of environmental benefits in addition to carbon sequestration.





Southwest Region

Geologic Sequestration Field Validations Tests

1. Aneth Deep Saline Sequestration and EOR Pilot Test (Aneth Field, Parodox Basin)

2. Permian Basin Sequestration and EOR Project (SACROC- Claytonville Fields, Permian Basin, near Snyder, TX)

3. San Juan Basin Sequestration and ECBM Pilot Test (San Juan Basin coal fairway, near Navajo City, NM)

Terrestrial Sequestration Field Validations Tests

1. Southwest Regional Terrestrial Pilot Test (Entire South West Region)

2. Terrestrial Riparian Restoration Project (San Juan Basin coal fairway, near Navajo City, NM)

SWP Field Validation Tests

Field sites, located in the San Juan, Paradox, and Permian Basins, are currently conducting tests on EOR, saline formation storage, ECBM, and terrestrial sequestration.

San Juan Basin Sequestration and ECBM Pilot Test— The SWP is conducting the San Juan Basin ECBM field validation test in cooperation with Burlington Resources. Commencing August 2007, about 68,000 metric tons (75,000 tons) of CO_2 will be injected over a one year period to evaluate CBM production efficiency and CO_2 storage optimization.

Terrestrial Riparian Restoration Project—The San Juan Basin ECBM project is also the location of one of the terrestrial sequestration pilot tests. Produced water from the ECBM project and other wells will be desalinated and applied to a riparian area – the interface between land and a flowing surface water body – where carbon storage will be monitored and evaluated.

Aneth Deep Saline Formation Sequestration and EOR Pilot Test—At the Aneth oil field near Bluff, Utah, the SWP demonstrates a combined CO_2 EOR and deep saline formation storage pilot on an active CO_2 EOR operation managed by Resolute Natural Resources Company and the Navajo Nation Oil and Gas Company. In January 2007, up to 145,000 metric tons (160,000 tons) of CO_2 per year over 3 years will be injected. Based on extensive geological characterization and detailed reservoir models, SWP will design MM&V protocols and conduct field studies.

Permian Basin Sequestration and EOR Project—The SWP is evaluating CO_2 EOR efficiency and CO_2 storage optimization at the SACROC-Claytonville field validation test, a combined EOR/CO_2 storage operation. In March 2008, about 159,000 metric tons (175,000 tons) of CO_2 per year for 1 ½ years will be injected. The geology of Aneth and SACROC-Claytonville, both carbonate reservoirs, is similar but their depth ranges vary, offering an opportunity to examine different hydrodynamic settings, which impact the flow and fate of CO_2 in the reservoir.